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URINE EVACUATING SYSTEM FOR USE IN FULL-PRESSURE SUITS

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FOREWORD

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ABSTRACT

A urine elimination system was designed and tested for use with full-pressure suits. This device utilizes differential pressures as the main principle, causing the urine flow. The device was used on 19 flights in the low pressure chamber at altitudes varying from sea level to 75,000 feet without one failure. With minor modifications this device can be used on any space suit and is a practical, comfortable, economical means of removing urine from the suit.

This technical documentary report has been reviewed and is approved.

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URINE EVACUATING SYSTEM FOR USE IN FULL-PRESSURE SUITS

1. INTRODUCTION

Personal protective equipment to support the airman against the physiologic hazards of altitude has been in existence since man began flying. Oxygen masks, protective helmets, anti-G garments, immersion suits and, more recently, high-altitude pressurizing suits have been developed and tested in response to operational requirements. The pressure suit concept is one in which the suit acts as a form-fitting pressure cabin should aircraft pressurization fail. Thus the individual is capable of completing his mission with his suit alone providing him protection against hypoxia and to some extent against decompression sickness. The mission length, until recently, has been measured in terms of hours and the existing operational pressure suits are quite capable of meeting these requirements.

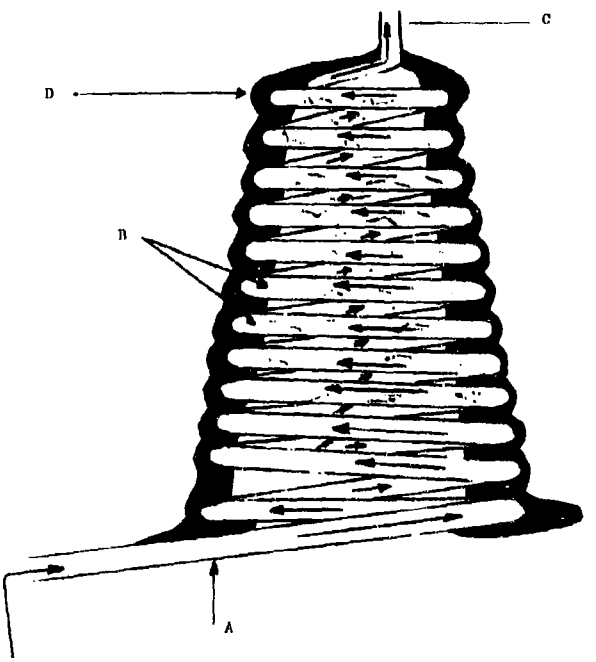

FIGURE 1

Air pressure or pressurizing air from the suit enters **A**. *Urine is evacuated into plastic tubing through slits and perforations* **B**. *The air pressure forces the urine out the exit* **C** *to the ambient to be collected or disposed of. Rubber molding* **D** *holds plastic tubing in the form desired.*

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Owing to the rapid advance of aerospace technology, however, certain mission requirements are now measured in terms of days. Cabin pressurization, whether it be a sealed cabin or conventional compressor-type cabin, is still the primary protective environment for space crews. Should the primary system fail, then the space crews would be required to live for days in their pressure suits. Certain modifications of existing pressure suits will have to be made in order to permit these longer stays. A urine evacuating system was, therefore, designed and tested for use with the A/P22S-2 and A/P22S-3 full-pressure suits.

2. THE EVACUATING SYSTEM

Description

The fundamental principle upon which this system operates is the fact that liquids or gases will flow from areas of high pressure to areas of low pressure. The internal environment of the pressure suit will always be at higher pressure, or can be increased to a pressure higher than the ambient pressure. The urine evacuating system, then, provides a means by which the urine can be made to flow from an individual in the high suit pressure to a receptacle in the lower ambient pressure.

Coiled, flexible (but not collapsible) plastic tubing with multiple perforations was coated externally with a liquid rubber cement. The somewhat rigid cone or cup thus formed fits loosely over the external genitalia (fig. 1). This cone is held in place by a shorts-type undergarment (fig. 2).

Plastic tubing is attached to the cone and brought up the torso of the individual and down the arm to the hand. Over the dorsum

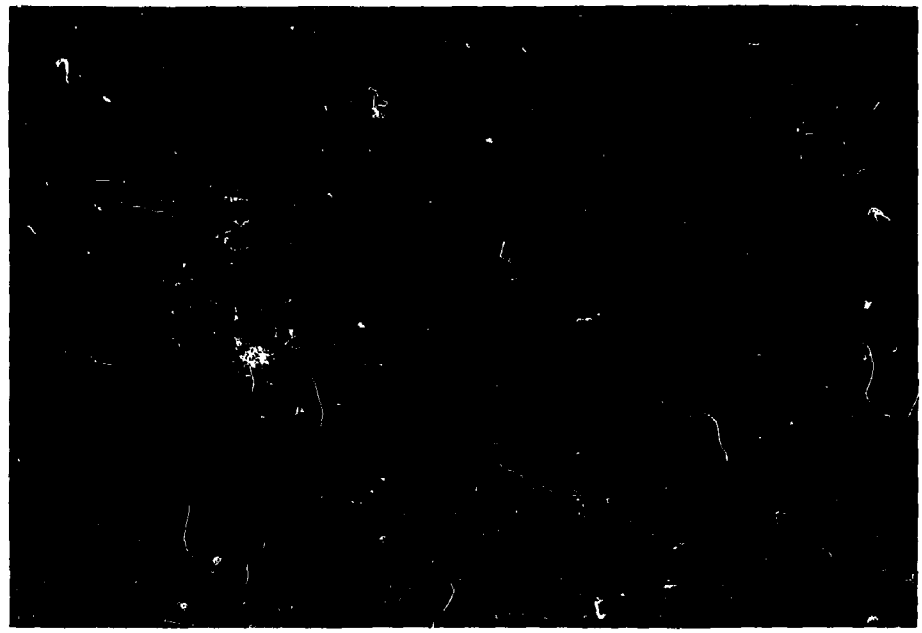

FIGURE 2

Undergarment which holds urine cup **A** *in place over external genitalia. Urine flows through tube* **B** *to suit penetration.*

of the hand this tubing is attached to the metal tube which penetrates the glove of the pressure suit. Figure 3 shows the glove penetration. Plastic tubing attached to the exit of the glove penetration runs to a turn valve which is used to control flow of air and urine through the system. Figure 4 shows schematically the working of this system. The urine can be collected either inside or outside the pressure chamber.

Operation

For this system to work efficiently there must be at least a 20 mm. Hg pressure differential between the inside and the outside of the suit. The greater the differential, the faster will be the urine flow. The flow can be easily regulated by manually controlling the opening in the turn valve.

When the full-pressure suit is uninflated, urine will not flow through the system. This situation exists when the ambient pressure is between 760 and 175 mm. Hg, which is equivalent to sea level and 35,500 feet altitude, respectively. Under these conditions the individual can pressurize his suit by using the press-to-test on the suit controller. This prevents the outflow of suit ventilation air through the controller and pressurizes the suit to approximately 100 mm. Hg above ambient. The individual now opens the urine-flow control valve which permits the air to flow through the urine system. Urine is collected in the cup around the external genitalia. The air flow forces the urine through the perforations in the coiled plastic tubing in the cone, up the torso tubing, and out through the glove penetration. The air flowing through the tube then dries the genital area as well as the tubing, thus preventing irritation and maceration

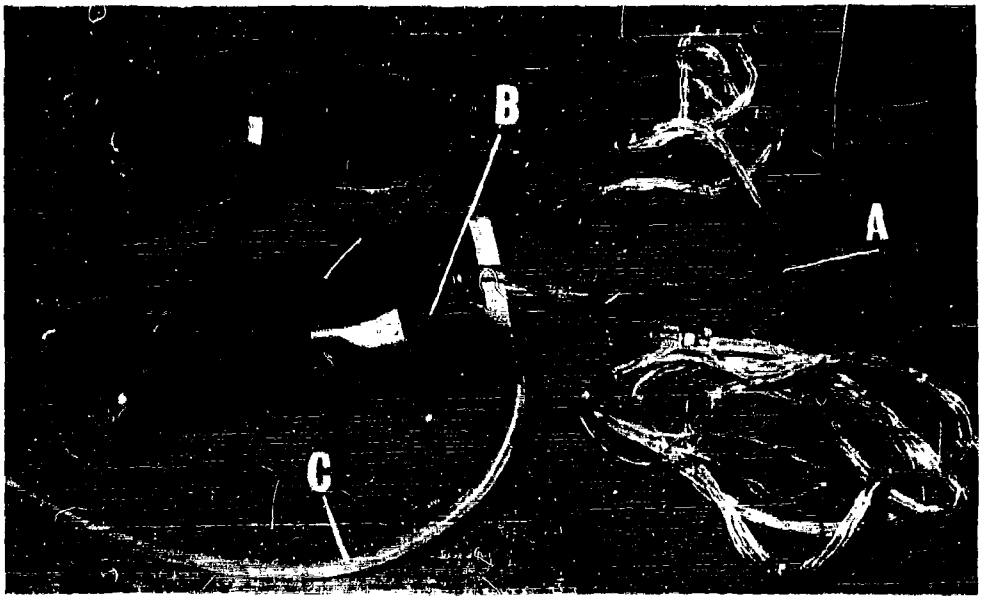

FIGURE 3

Urine flows from tube A *which is attached to urine cup and then out through glove penetration* B. *Tube* C *leads to the urine flow control valve.*

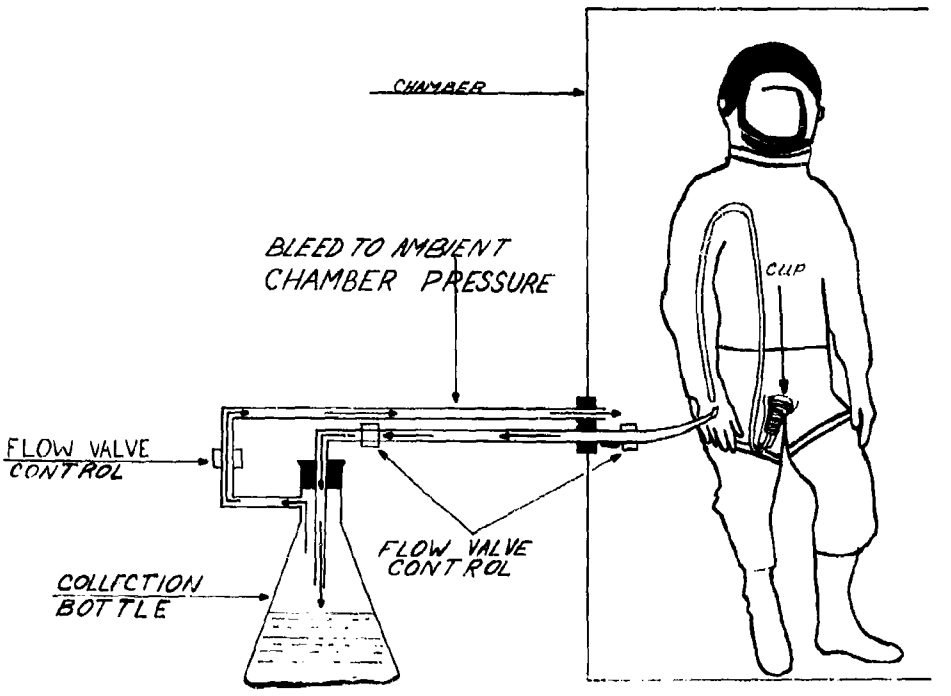

FIGURE 4

Schematic drawing of urine elimination system as it operates in low pressure chamber. The urine is collected in the cup and flows out the suit through the flow control valves to the collection bottle. The bottle is then tapped to the ambient pressure within the chamber.

of the skin. Closing the urine control valve stops the air flow and releasing the press-to-test permits the pressure to bleed off through the suit controller. Under this situation, the subject must again activate the press-to-test on the suit controller, open the urine control valve, and then urinate.

If the individual is above 35,500 feet or at a barometric pressure lower than 175 mm. Hg, the suit is pressurized normally, and a pressure differential exists. All that is necessary under these circumstances is to open the urine control valve and urinate. Since the pressurizing gas flows out of the suit through the urine system, there is a momentary drop of 2 to 4 mm. Hg suit pressure which is immediately compensated by the suit controller.

3. RESULTS OF TEST ON URINE EVACUATING SYSTEM

Nineteen pressure suit flights were conducted in the low pressure chamber in order to test this urine evacuating system. Five flights were conducted at ground level and 2 flights at 35,000 feet. These flights determined the adequacy of the press-to-test system to provide urine flow from the suit. Twelve flights were conducted at 75,000 feet. These flights were to determine the adequacy of normal suit pressure to cause flow of urine out of the suit.

On every flight the subject was requested to drink 500 cc. of water prior to being fitted in either the A/P22S-2 or A/P22S-3 full-pressure suit. The urine system was fitted to the

subject and after one hour of denitrogenation the flight was begun. The subject was held at the test altitude until urination was accomplished. He was then brought to ground level and examined by the flight medical officer to determine if there was any trauma to the genital region or if there was any evidence of residual urine in this area. The subject was then questioned as to his opinion of the urine system.

On every flight the urine was completely evacuated from the suit and the subject's genital region was completely dry. There was no evidence of trauma to the genitalia, nor were there any complaints from the subject.

4. DISCUSSION

During space flights, there is a possibility that crews will be required to live for periods of at least several days within a space suit. Disposal of body waste in some manner will be required. While defecation can be controlled to some extent by low residue diets prior to and during flights, an obligate urine flow is absolutely essential. This means that the subjects must have unrestricted amounts of water. Some provision must then be made to remove the urine from the suit. The urine evacuating system described in this report is an effective device for removal of urine from the suit.

This system utilizes pressure differentials to cause urine flow. The only malfunction that can cause the urine system to fail would be the failure of the suit to pressurize. Under this circumstance the pressure suit would no longer be affording any protection, and urine collection would be a secondary problem.

The penetration for the urine evacuation system can be placed anywhere on the suit by any capable suit technician. The glove was chosen on these flights since other data (ECG and blood pressure) were being collected; the glove was a convenient location for bringing out all the leads.

5. CONCLUSION

This urine evacuating system was used with the A/P22S-2 and A/P22S-3 full-pressure suits because these are the full-pressure suits presently in the Air Force inventory. It has fulfilled every requirement, on all tests conducted to date, without a single failure. With some modification, the system could be used with any other full-pressure suit, and have the advantage of being free from dependence upon gravity for operation. This means that under zero, plus, or minus G-forces encountered in space flight, urine evacuation would not be a problem.